OR0801

Optimization of the mechanical properties of a-C:H DLC coatings

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Diamond-like carbon coatings containing hydrogen were deposited by use of reactive DC magnetron sputtering with an industrial deposition system. The reactive gas C_2H_2 was used in combination with carbon targets. The concentration of carbon and impurities in the coatings was measured with X-ray Photoelectron Spectroscopy, and the hydrogen content was obtained using Secondary Ion Mass Spectroscopy. The ratio of the signals of HCs^+ and CCs^+ (the primary ions were Cs^+) yielded the hydrogen content. From Raman-spectroscopy data, the ratio between the intensities of the D and G peak was calculated – yielding information on the fraction of sp^3 hybridized carbon atoms – and the compressive stress was obtained from the position of the G peak. The mechanical properties of the coatings – hardness, E-modulus and fracture toughness – were extracted from nanoindentation data, and Rockwell C adhesion tests gave a measure of the adhesion strength. By systematic variation of the deposition parameters, the mechanical properties were optimized. The focus was on the influence of the hydrogen content on the mechanical properties. To increase the adhesion strength, thermal annealing was carried out. This annealing resulted in lower compressive stresses leading to stronger adhesion, while the hardness was nearly constant, although the hydrogen content decreased with increasing annealing temperature.

Keywords
DLC coatings
Magnetron sputtering
stress
nanoindentation
Raman spectroscopy